

PERI InSite Construction Data Acquisition System

Instructions for Installation and Use – Technical Cabinet with Main Unit and Nodes – Version 1.1

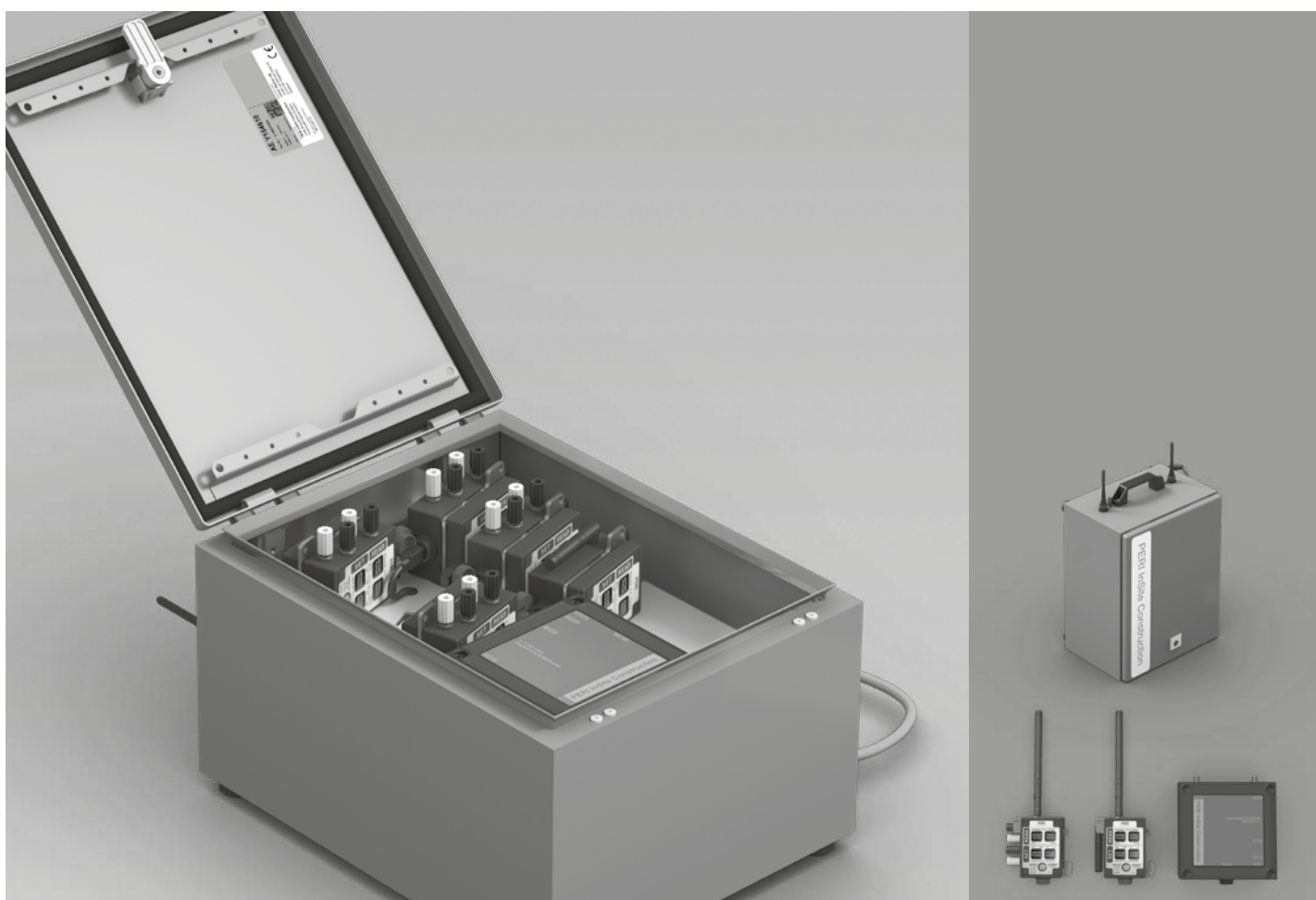


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1 Preface

1.1 Disclaimer

Vemaventuri AB reserves the right to revise this publication at any time without incurring an obligation to notify any person of the revision.

All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer shall perform repairs to components.

Failure to observe this information can result in injury or equipment damage.

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TRADEMARKS

PERI InSite Construction is a brand name of PERI GmbH, Germany. Vemaventuri AB is a part of the PERI GmbH and therefore can be used interchangeably. Vemaventuri AB has made every effort to supply trademark information about company names, products and services mentioned in this manual. Trademarks shown below were derived from various sources. All trademarks are the property of their respective owners.

1.2 Description of the User

This document, (“the Instructions for Installation and Use”), is intended for personnel skilled in the field of concrete construction that use the PERI InSite Data Acquisition system (“the System”) in their line of work within the construction industry.

The users of The System are expected to have the necessary concrete engineering expertise to lead and monitor the process of concrete pouring and curing in professional construction- and civil engineering projects.

1.3 Conventions used in this document

The following style conventions are used in this document:

Bold

Names of product elements, commands, options, programs, processes, services, and utilities
 Names of interface elements (windows, dialog boxes, buttons, fields, and menus)
 Interface elements the user selects, clicks, presses, or types.

Italic

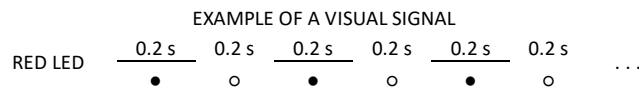
Publication titles referenced in text
 Emphasis (for example a new term)

Variables

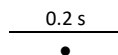
Courier

System output, such as an error message or script
 User input, such as text in a textbox
 Complete paths, filenames, prompts, and syntax

Visual signals (LED lamp indicators)



where the time the LED being lit is indicated by



and the time the LED being off is indicated by



a continued indication is indicated with trailing “. . .”

1.4 Explanation of Safety Warnings

⚠ DANGER	Danger indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
⚠ WARNING	Warning indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Caution indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates information considered important, but not hazard-related.

1.5 Retaining Instructions

Read and understand this manual and its safety instructions before using this product. Failure to do so can result in serious injury or death.

Follow all the instructions. This will avoid fire, explosions, electric shocks or other hazards that may result in damage to property and/or severe or fatal injuries.

The product shall only be used by persons who have fully read and understand the contents of this *Instructions for Installation and Use*.

Ensure that each person who uses the product has read these warnings and instructions and follows them.

Keep all safety information and instructions for future reference and pass them on to subsequent users of the product.

The manufacturer is not liable for cases of material damage or personal injury caused by incorrect handling or non-compliance with the safety instructions. In such cases, the warranty will be voided.

1.6 Obtaining Documentation and Information

1.6.1 Ordering Documentation

Documentation, user instructions and technical information are provided with each Main Unit. Further documentation can be found under <https://www.distant.se>, <https://www.peri.com> or by contacting your local PERI subsidiary or check the PERI subsidiary website.

1.6.2 Other languages

This is the English *Instructions for Installation and Use*. For other languages, please contact your local PERI subsidiary.

1.6.3 Documentation Feedback

If you are reading Vemaventuri AB product documentation on the internet, any comments or feedback can be submitted on the support website. Feedback can also be sent to info@vemaventuri.se. We appreciate your feedback.

1.6.4 Support and service

For information about special tools and materials, further information, technical assistance or ordering please contact your PERI subsidiary or support.formwork@peri.de.

1.7 Keywords

HCS	Hazard Communication Standard
OSHA	Occupational Safety and Health Administration
GHS	Global Harmonized Standard
SDS	Safety Data Sheet
MSDS	Material Safety Data Sheet
ICAO	International Civil Aviation Organization
IATA	International Air Transport Association
DGR	Dangerous Goods Regulation
TI	Technical Information
IMO	International Maritime Organization
IMDG Code	International Maritime Dangerous Goods Code
RID	International Carriage of Dangerous Goods by Rail
ADR	International Carriage of Dangerous Goods by Road
USDOT	US Department of Transport
GSM	Global System for Mobile Communication
EEA	European Economic Area
IP	Ingress Protection
EU	European Union
ISO	International Organization for Standardization
PE	Protective Earth
AC	Alternating Current
DC	Direct Current
ESD	Electrostatic Discharge
LR	Log Rate, the time interval on which the node will measure
UR	Upload Rate, the time interval on which the node will upload data
CR	Connection Rate, the time interval on which the Main Unit will connect to the Internet

2 Safety Instructions

Read and gain an understanding of the safety instructions!

⚠ DANGER

Read and understand this *Instructions for Installation and Use* and safety instructions before using this product. Failure to do so can result in serious injury or death.

Protect the mains cable from excessive wear and tear!

⚠ DANGER

Protect the mains cable from sharp edges, abrasive surfaces and cutting tools. Do not use the mains cable as a means of attaching or hanging the Technical Cabinet from any support structure. Make sure the mains cable is protected from traffic by cars or equipment running on tracks or wheels that could damage the cable.

Do not expose the inside of the technical cabinet to water!

⚠ DANGER

Do not expose the inside of the Technical Cabinet to water or concrete. Make sure the Technical Cabinet is closed at all times during normal operation.

Do not place the Technical Cabinet where it can fall!

⚠ DANGER

Install the Technical Cabinet on an even surface and make sure it cannot fall and cause injuries to personnel or equipment below.

Do not connect the mains cable to an outlet without PE lead!

⚠ DANGER

The Technical Cabinet mains cable should only be connected to a mains outlet with Protective Earth. Failure to do so in combination with faulty equipment could lead to fatal electric shock.

Route the mains cable in a safe way!

⚠ CAUTION

Make sure the mains cable is routed in a way that it is not entangled in moving machinery or stumbled upon by personnel working in its vicinity.

Do not operate the equipment without the antennas!

NOTICE

Do not operate the equipment without the antennas properly installed and do not operate the Nodes when they are installed in the charging position inside the Technical Cabinet. Make sure the Main Unit is given time to connect a last time after turning it off before removing the antennas.

Avoid subjecting exposed signal connectors to ESD!

NOTICE

Do not touch exposed signal connectors directly as it can damage them due to electrostatic discharge (ESD) from the human body.

2.1 How to use the System safely

This section provides general information about safety and intended use of The System. The life span and the recycling of the product are also explained in this section.

2.1.1 General Safety Instructions:

- The System must only be set up, started or used after reading this *Instructions for Installation and Use* and in particular the Safety Instructions in the beginning of this chapter.
- The System should be protected from rain and other environmental conditions that can cause unwanted situations and can reduce The System performance and life span. Although the Nodes and the Technical Cabinet (when closed) is designed to withstand normal weather conditions it is recommended to place the equipment shielded from rain, wind and sun if possible.
- The System and all its parts must be used for the intended purpose as described in this *Instructions for Installation and Use*.
- The System is not ATEX (Atmosphere Explosive) certified therefore it must not be operated in potentially explosive atmospheres.
- During the operation of The System any work method that hinders the safety of The System is prohibited.
- The Technical Cabinet should not be placed in mud or snow, hanged in its mains cable or carrying handle. Take care not to place the equipment where it could fall down and cause injury.
- The System must be used under the defined working conditions in this *Instructions for Installation and Use*.
- All the tags, compliance information and the safety instructions on The Technical Cabinet should be protected.
- The System and all its parts must be installed and operated by the trained personnel.
- In case of malfunctioning and fault The System should be repair and install correctly by the trained and authorized personnel before further use.

⚠ WARNING

The System should only be operated by skilled adult professionals. Advanced operations shall only be done by a qualified and trained service engineer. There are no user serviceable parts inside.

2.1.2 Technical life span

The System and all its parts have technical life span of 5 years.

2.1.3 Intended Use

The System and all its parts are designed for its intended use as described in this *Instructions for Installation and Use*. The System must be used and installed by the trained experts and the users must be aware with possible hazards and danger. The System is intended to use within the EEA, therefore it applies all the industry specific and other mandatory laws of the country where The System being used. The safety instructions in this *Instructions for Installation and Use* must be followed by the user, the user is solely responsible for the actions which goes beyond the intended use of The System. The manufacturer is not responsible for any damage or unexpected results from unintended use of the equipment.

2.1.4 Safety information related to the use of the product in residential areas

The System is in compliance with the EU Radio Equipment Directive (RED) 2014/53/EU and have been fully tested for risk assessment according to Low Voltage Directive (LVD) 2014/35/EU, therefore it is safe to use in industrial and residential areas where the radio communication do not affect the possible surroundings.

2.1.5 Personal protective Equipment

The System does not contain any moving parts or corrosive substances. However, the installation and subsequent use of The System in a work site environment could subject the user from the normal hazards expected in such an environment. Protective glasses, gloves and protective clothing as well as hearing protection shall be worn by the user when working with fresh concrete and operating power tools in a construction site environment. Respect local work site safety regulations at all times.

2.1.6 Possible Hazards when misuse:

The user safety must always be followed during installation, transportation and maintenance of The System. Every part of The System complies to the related EUs directives. The metal, plastic, printed circuit board, electronic components and batteries used in The System are not classified as hazardous chemicals according to Appendix A and Appendix B by HCS, general industry-Division 2/Z 1910.1200 of GHS-Aligned Hazard Communication by Oregon OSHA Standards and Technical Resources Section Publications, when The System is used as intended.

The HCS defines a hazardous chemical as any chemical that is classified as a physical hazard, a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas or a hazard not otherwise classified.

Metal steel, plastic and batteries can cause problems if treated not as intended e.g. burning and heating batteries above nominal temperature. Therefore it is recommended that,

- The System must never be used in extreme environmental conditions.
- Never exceed the temperature and humidity conditions as described in this *Instructions for Installation and Use*.
- The faulty parts of The System must be replaced at the workshop approved by the manufacturer.
- The System is mounted by the technical professionals, therefore the configuration and the parts installed within The System must never be removed or replaced before consulting with manufacturer.

The possible Hazards, first aid measures and firefighting measures for the lithium ion batteries are described in data sheet attached in appendix B.

2.1.7 Installation safety information

The System should be protected from water, snow, mud, fresh concrete and extra humid environmental conditions and must not be installed so that it can fall and cause injury. The AC mains cable must be protected from damage and routed so that humans, animals or vehicles can't get tangled up in it.

2.1.8 Safety information regarding the use

The user safety information described in this *Instructions for Installation and Use* must be followed by the professionals using the System.

2.1.9 Maintenance safety information

Remove any concrete residue or spills from the equipment as soon as possible. Hardened concrete is difficult to remove without damaging the equipment.

2.1.10 Service and repair safety information

The System does not contain any parts serviceable by the user inside. All repairs should be carried out by manufacturers accredited service workshop.

2.1.11 Safe Disposal

Defunct equipment is not to be treated as unsorted municipal. It must be collected separately and should be handled as electronic waste. The end users must follow the local rules and regulations to recycle the product.

2.2 Graphical Symbols

2.2.1 Explanation of safety information

Symbol	Meaning
	The CE Marking on the product is the manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety and environmental protection legislation.
	In Finland, Norway and Sweden, CLASS I PLUGGABLE EQUIPMENT TYPE A intended for connection to other equipment or a network, must, if safety relies on connection to protective earth or if surge suppressors are connected between the network terminals and accessible parts, have a marking stating that the equipment must be connected to an earthed mains socket-outlet.
	The symbol on the product, the accessories or packaging indicates that this device must not be treated as unsorted municipal waste but must be collected separately. The black line under the crossed wheelie bin indicated that the products are placed on the market after 2005.
	Class 9 Miscellaneous Goods. Dangerous Goods Regulations The packaging contains dangerous goods.
	Dangerous Goods Regulations Package containing Lithium Ion Batteries

2.2.2 Explanation of graphical symbols

Symbol	Meaning
	RoHS Restriction of Hazardous Substances. The components used in the manufacturing of The System have RoHS compliance.
	CE "Conformité Européenne" French for European Conformity
	WEEE European Waste Electrical and Electronic Equipment Directive means that The Technical Cabinet and all its parts must be recycled according to the local (the country system being used) regulatory law.
	CSA The technical Cabinet is tested according to CSA Group's Industrial Control Panel (ICP) standards.
	UL The technical cabinet have compliance with product safety standards of Underwriter Laboratories.
	TUV The technical cabinet have product quality testing certification by TUV. "Technischer Überwachungsverein" German for Association for Technical Inspection.

2.3 Potential Health Consequences

Under normal operation of The System there are no health consequences to take into consideration.

2.4 Personal Protection

In case of The System is mechanically damaged or any release of leakages, the following safety equipment must be used,

PPE	Instruction
Eye protection	Use goggles or glasses.
Hand protection	Synthetic rubber or cloths gloves, no direct contact in case of fire.
Hearing protection	Use safety earbuds from harmful noise level.
Protective shoes	Protect the feet from piercing and heavy elements.

3 Description of the System

3.1 Intended use and reasonably foreseeable misuse

The System is intended to be used solely as a Data Acquisition System in construction and civil engineering projects within the European Economic Area (EEA). The System is not a consumer product and should only be used by trained professionals. The System uses the following frequency bands for radio and GSM communication:

Main Unit L-11 on multiple markets:

GSM: 900 MHz, 1800 MHz, 1900 MHz

LTE-TDD: B38/B40/B41

LTE-FDD: B1/B3/B5/B7/B8/B20

UMTS/HSPA+: B1/B5/B8

GSM/GPRS/EDGE: B3/B8

Nodes on the European market:

Proprietary encrypted data transfer protocol: 868 MHz – 870 MHz

The System shall be used in conjunction with the Web Portal and original PERI accessories such as thermocouple cable, type T. The information provided in this *Instructions for Installation and Use* has been upon the current level of information available, for the purpose of specifying the requirements regarding environment, health and safety in association with The System. The manufacturer does not take any responsibility for wrong using, processing and handling of The System by the end-user.

The data and other information provided in this *Instructions for Installation and Use* are only applicable to the products (The System) sold by the Vemaventuri AB and not by any third party. This *Instructions for Installation and Use* is valid only when The System is used as intended and does not used with any other product combination. The end-user solely responsible for transportation, handling, Storing, recycling, and disposing of The System. Vemaventuri AB is not responsible for any warranties of any kind and nature or any injury resulting from abnormal use (not intended) of The System.

3.2 Geographical Restrictions

The System is only intended to be used within the European Economic Area (EEA). The all units of The System have CE compliance and a CE mark will be affix to every unit of The System.

Radio Equipment Directive 2014/53/EU requires that in cases of restrictions on putting into service or of requirements for authorization of use, information available on the packaging shall allow the identification of the Member States or the geographical area within a Member State where restrictions on putting into service or requirements for authorization of use exist and that such information shall be completed in the instructions accompanying the radio equipment.

NOTICE

The System is not intended for use outside the European Economic Area (EEA). Activating or even importing radio transmitters in some countries outside the European Economic Area (EEA) could be illegal. Refer to national regulations concerning the radio frequency bands used.

3.3 System Overview

The PERI InSite Construction Data Acquisition System (“the System”) consists of thermocouple (N-TE) and ambient climate or pressure (N-TRF) nodes paired with the Main Unit L-11 permanently mounted in the Technical Cabinet.

The Technical Cabinet protects the Main Unit and serves as a charging station for the Nodes when they are not in operation of collecting data.

When the System is in operation, the Nodes collect data such as temperature measured with a connected thermocouple and transmits this data on pre-set time intervals to the Main Unit using a proprietary encrypted protocol over the 868 MHz radio frequency band.

Data from the Nodes along with a record of the measurement time (timestamp) are temporarily stored on the Main Unit for further forwarding to the Internet on set time intervals.

Once transferred to the Web Portal on the Internet the measured data can be accessed and further processed using the Web Portal by the user.

Nodes can be configured as repeaters, in effect increasing the radio transmission range significantly. The repeater functionality can be turned on from the Web Portal. When in repeater mode, the Nodes draw more current from the battery, but the maximum radio range of the System is increased substantially.

Figure 1 depicts a typical system setup with Node 01 being of the type N-TRF measuring the ambient climate (temperature and air humidity) and five Nodes (02 – 06) of the type N-TE measuring temperature (e.g. in concrete) in two points each using connected thermocouples.

Note that node number 06 is configured as a repeater extending the range for nodes in the vicinity. The Main Unit L-11 inside the Technical Cabinet acts as a gateway linking the connected nodes to the Internet based cloud services (the Web Portal).

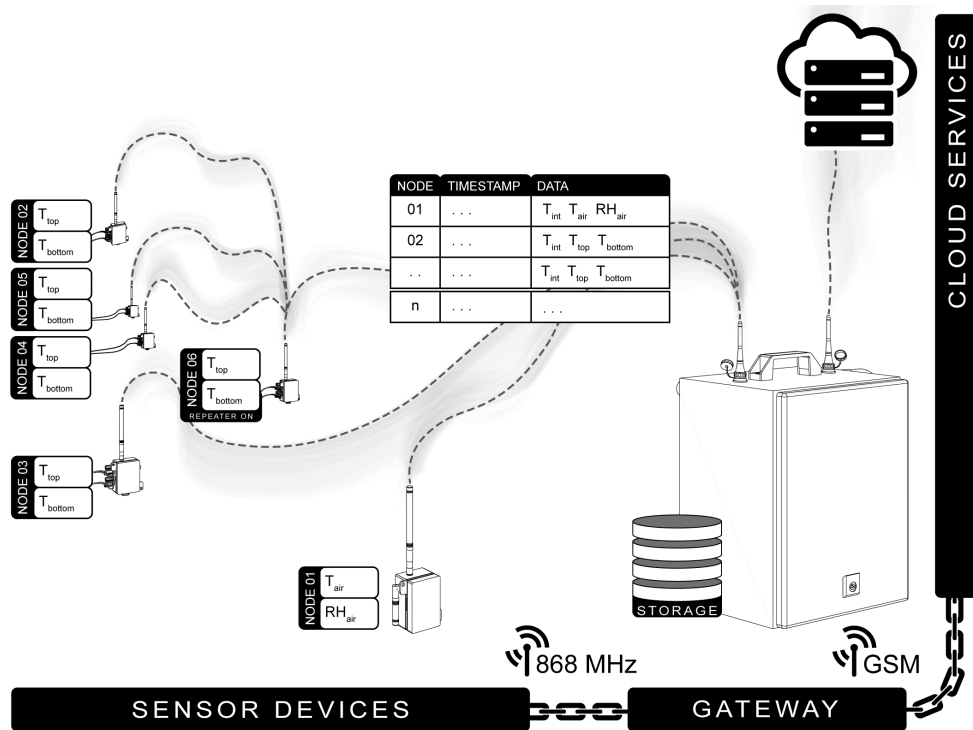


Figure 1 - Overview of a typical setup

3.4 Technical Data

Unless otherwise specifically stated in the *Instructions for Installation and Use*, the equipment has been designed for the following service conditions.

Technical Cabinet Gen IV

3.4.1 Operating Environment

Max. Operating Temperature	-25 °C to +55 °C
Maximum Operating Humidity	≤ 95 % (at 25 °C, non-condensing)
Long term storage Temperature	+10 °C to +25 °C

3.4.2 Inputs and Outputs

Nominal input voltage	100 V – 240 V AC
Nominal charging voltage	5V DC ±1 %
Maximum input current	630mA @220 V AC
Nominal output current	6.5 A (-25 °C to +55 °C)
Output Power	32.5 W
Nominal power consumption	72.1 VA

3.4.3 Electrical Specifications

Communication technique	Radio Frequency Wave Modulation
Max. Transmitting power	27 dBm
Max. Transmitting range	Up to 2 km (line-of-sight)
Max. Signal output power	10 dBm
Earthing system	PE
Technical Life Span	5 years
Expiry Date	5 years from date of production
Maximum total charging current	6.5 A
Chemical composition	Metal, Plastic, PCB and Electronics, Battery

3.4.4 Physical and Mechanical specifications.

Ingress Protection (IP) Rating	IP 66 EN 60529
Weight	12 kg
State	Physical solid
Shape	Rectangular box with extending components
Mass/Dimensions (L×W×H) cm	48×30×21 cm
Cable length	2.9 m
Node charging cable length	10 cm

3.5 Regulatory Compliance

The System has been thoroughly tested to ensure EMC compliance with relevant EU directives and Harmonized Standards. The System is in compliance with the following product safety standards:

Radio Equipment Directive (RED) 2014/53/EU

Electromagnetic Compatibility Directive (EMC) 2014/30/EU

Low Voltage Directive (LVD) 2014/35/EU

Restriction of Hazardous Substances in Electronic Equipment (RoHS) Directive. 2011/65/EU

Waste of Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU)

3.6 Product elements

Refer to the inside cover and its following pages for illustrations. The System has three main elements:

1. Technical Cabinet with its Charging Bay for six nodes
2. Main Unit model L-11
3. Nodes (N-TE, N-TRF)

3.6.1 Technical Cabinet

The Technical Cabinet protects the Main Unit and Nodes. It has a built-in AC-DC step-down transformer for power supply of the Main Unit and up to six Nodes attached to the Charging Bay and connected with their respective USB charging cables.

The Technical Cabinet has two antenna connectors with protective plastic caps. During transport and storage, the protective caps shall be placed on the antenna connectors. Before switching the Main Unit ON and taking The System into operational mode the protective caps should be removed, and the antennas must be installed in their place. During operation The Technical Cabinet should be connected to an AC mains outlet (100V – 240V /45Hz – 65Hz) with protective earth. The mains cable must be protected from damage. The technical cabinet is in conformity with ISO 14040 environmental assessment.

3.6.2 Main Unit model L-11

The Main Unit functions as a gateway to the Internet. It relays data collected by the nodes and forwards it on set time intervals (“Connection Rate”, CR) via the GSM network to the internet and the web services located on the Web Portal (www.distant.se). The Main Unit is permanently installed in the Technical Cabinet to protect it from the harsh environment on the construction site.

In case of a temporary power outage an internal battery inside the Main Unit can supply the necessary power for normal operation for a limited amount of time – normally 12 to 24 hours depending on settings and the local radio conditions.

3.6.3 Nodes

The Nodes functions as traditional data loggers but have a built-in radio for two way radio communication with the Main Unit. The data is collected on set time intervals (Log Rate) and uploaded to the Main Unit on another set time interval (Upload Rate). There are different Node types with different functionalities. All Node types features an internal temperature sensor. The Nodes contain a lithium ion battery that needs to be charged at regular intervals.

A completely discharged battery requires approximately 12 hours of charging to regain full capacity.

During normal use the Node battery will last between one and six months between charging. However, if the Nodes are configured as repeaters and / or during high data load significantly shorter battery life can be expected.

Refer to Illustrations Page 2 for visual illustrations.

3.6.3.1 Ambient Climate Node (N-TRF) to monitor the ambient climate or concrete pressure

The Node type N-TRF is used to monitor the ambient climate and features a temperature and humidity sensor. The ambient climate sensor is replaceable and available as a spare part.

A typical use case for the N-TRF node is to monitor the indoor climate inside a building being erected or the outdoor climate surrounding a newly cast concrete construction.

The Node type N-TRF can be used in combination with the climate or the pressure sensor.

A typical use case for the pressure sensor is the monitoring of concrete pressure acting on the formwork.

3.6.3.2 Temperature Node (N-TE) to monitor the temperature using a thermocouple

The Node type N-TE features two input channels for thermocouples type T.

A typical use case for the N-TE node is to monitor the temperature in newly poured concrete in order to calculate the maturity age and, when the actual concrete's temperature sensitivity is known prognosticate the compressive strength. The thermocouples are typically fastened to the rebar before the pour begins. Another typical use case is to monitor the temperature during winter casting to ensure the young concrete is not subjected to freezing in a too early age.

It is also possible to monitor the temperature in cooling or heating pipes so that the temperature difference between the inlet and outlet can be calculated.

3.7 The hardware user interface

3.7.1 The Node

3.7.1.1 Keypad

Although all settings for The System can be accessed through the Web Portal the keypad on the Nodes has a number of functions that can be handy for the user. Figure 2 depicts the Node with its keypad featuring two buttons to read battery status and signal quality respectively **[A]**, two buttons to change settings **[C]** as well as the power button **[D]** and the four LED indicator lamps **[B]**.

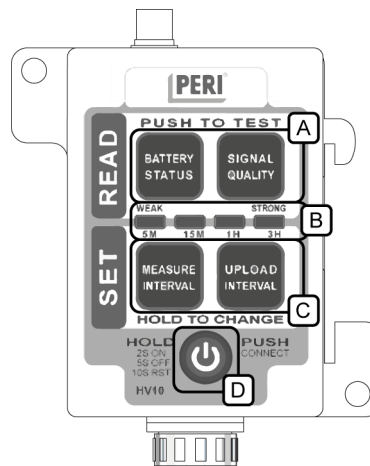


Figure 2 - The Node Keypad

3.7.1.2 Basic functionality of the Node – On/Off, Reset and Force Connect

3.7.1.2.1 Turning the Node on

The node is turned on by pressing the power button **[D]** for 2 seconds. It will immediately try to establish a connection to the Main Unit it has been paired with. While the connection is established the LED indicators **[B]** will scroll from right to left and then back again.

As soon as a connection is established the LED indicator lamps will turn off and the Node will resume to normal operation using any new settings communicated to the Main Unit. If a connection cannot be established within ten minutes of continuous attempts the Node will resume normal operation using its last known settings.

3.7.1.2.2 Turning the Node off

By holding the power button for 5 seconds the Node can be turned off. Always turn off the node when it is not in use. Nodes that are turned on will continue collecting data even if the Main Unit is switched off. This can lead to a big collection of useless data and can cause problems when the Node connects the next time to the Main Unit and all this data is send.

3.7.1.2.3 Forcing the node to connect to the Main Unit

By pressing the Power Button once a Force Connect, FC, will be issued where the Node will try to connect to the Main Unit. If there are new measurement data not yet transferred to the Main Unit an upload will commence. The LED indicator lamps will signal this by scrolling from left to right until all data is transferred. This can take up to 60 seconds. When all is done and the Force Connect was successful all four LED indicator lamps will light up once. The node will then resume normal operation.

3.7.1.2.4 Resetting the node

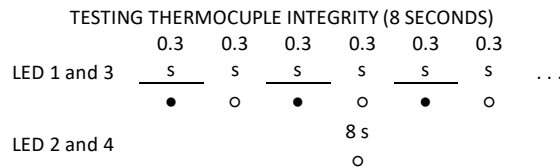
The Node can be reset by holding the power button for 10 seconds as shown on the keypads settings. Performing a Reset will not clear the Node memory from measured data.

3.7.1.3 Read battery status and signal quality

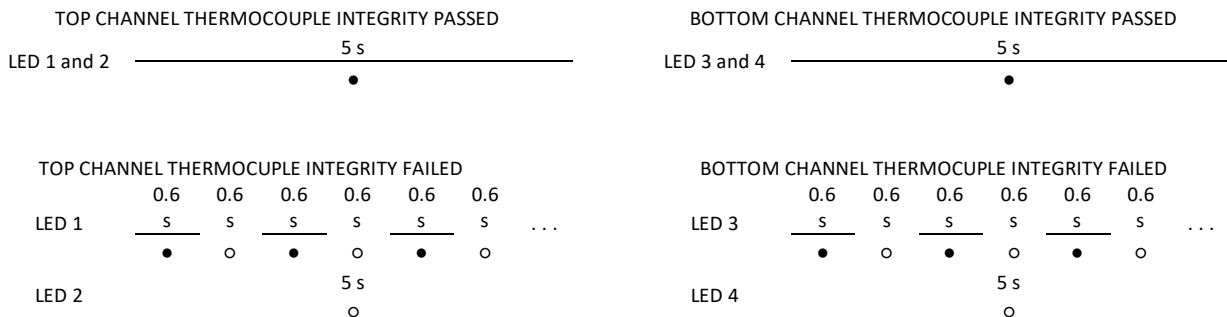
The “**READ**” section [A] of the keypad enables the User to read battery status and the signal quality. By pressing “**BATTERY STATUS**” the Node shows the battery charge level by lighting the LED indicators [B] referring to the scale above them; WEAK to STRONG. Pressing “**SIGNAL QUALITY**” makes the Node show the radio signal strength measured between the Main Unit and the Node at hand referring to the scale above them; WEAK to STRONG. No signal is indicated with the WEAK indicator flashing for a few seconds.

3.7.1.4 Check thermocouple integrity (Node type N-TE only)

Press both “**BATTERY STATUS**” and “**SIGNAL QUALITY**” on the N-TE Node to perform a thermocouple integrity check. The Node will test the thermocouple channels for eight seconds and then signal the result on the LED indicator lamps. During the test LED 1 and 3 will flash at a rapid rate until the test is complete.



Once the test is complete the two leftmost LED’s (LED 1 and 2) signals the status of the TOP channel and the two rightmost LED’s (LED 3 and 4) signals the status of the BOTTOM channel.



NOTICE

The thermocouple integrity test will fail under the following circumstances:

1. No thermocouple is connected.
2. The connected thermocouple is damaged (broken lead).
3. The connected thermocouple is not properly short circuited in the measurement end.

Thermocouples can be tested using the diode testing function of a multimeter.

3.7.1.5 Set measurement and upload interval

The “**SET**” section **[C]** of the keypad have both read and write functions. By pressing the “**MEASUREMENT INTERVAL**” the LED indicators **[B]** signals the data measurement interval (the “Log Rate”, LR) set by the user referring to the scale below them; 5 minutes, 15 minutes, 1 hour and 3 hours. Similarly, when the “**UPLOAD INTERVAL**” is pressed the node indicates how often data is uploaded to the Main Unit (the “Upload Rate”, UR) using the same scale.

If an arbitrary setting has been made through the Web Portal of the Log Rate or Upload Rate respectively the node will signal this by flashing all four LED indicators three times. This setting can be overridden by the User using the keypad at any time.

To change the Upload Rate or the Log Rate, press and hold the respective button for two seconds. Then press the same button repeatedly until the desired interval is indicated using the scale below them; 5 minutes, 15 minutes, 1 hour and 3 hours. After four seconds of inactivity the Node shows the selected interval and then resumes its normal operation with the set value.

3.7.1.6 Important notice on the Node user interface

NOTICE

Please note the following:

When Log Rate or Upload Rate respectively have been set from Web Portal, the node LED indicators will signal this by blinking all at once four times. These settings can be overridden by changing them using the Node Keypad.

Resetting the node can sometimes mitigate problems and is the first solution one can try during fault finding. Performing the reset will clear the Node memory and restart the firmware but it will not affect the measurement data stored in the Node.

All settings available through the Keypad is also available through the Web Portal. It is recommended to select the appropriate settings during the start of the measurement session. This way all nodes will automatically receive their setting at the same time and there will be no need to change the settings on each individual Node.

3.7.2 Main Unit model L-11

The Main Unit acts as a gateway to the Internet in effect transferring the data collected by the paired Nodes via the mobile phone network to the Web Portal where it can be accessed by the user. The Main Unit also acts as a buffer storage for data not yet transferred. If the communication between the Main Unit and the Internet for some reason is interrupted, the Main Unit will buffer the collected data until a connection can be re-established.

Normally the Main Unit is powered through the Technical Cabinets built in AC-DC power supply through the USB cable emerging from the Charging Bay. If the mains supply for some reason is interrupted an internal back-up battery takes over and provides power for up to 24 hours of normal operation. How long the back-up battery can uphold normal operation depends on data load and communication settings.

Figure 3 depicts the Main Unit with the Rocker Switch **[A]** and the LED indicator lamps **[B]** highlighted. The main unit also has a built-in buzzer capable of playing simple tones to indicate ongoing activity.

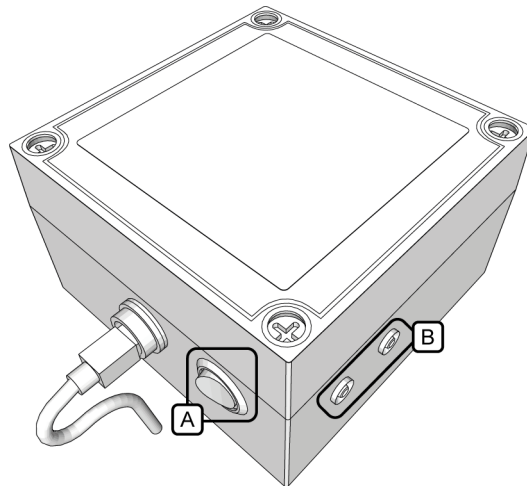


Figure 3 - Main Unit model L-11 with the Rocker Switch and the LED indicator lamps highlighted

3.7.2.1 On-Off Rocker Switch

3.7.2.1.1 Turning the Main Unit on

When the rocker switch **[A]** is pushed to the “I” position the unit is turned on and initiates the start-up procedure. The buzzer on the Main Unit plays a short series of notes to indicate it has been turned on while the green LED lamp **[B]** indicates a first connection to the Web Portal is being initialized.

“♪♪ ♪♪”

3.7.2.1.2 Turning the main unit off

When the rocker switch **[A]** is pushed to the “0” position the unit initiates the close-down sequence. A last connection attempt is carried out in order to convey the information that it has been turned off to the Web Portal. The buzzer plays a two-note signal to indicate that it will turn OFF after trying to connect a last time.

“♪ ♪”

3.7.2.1.3 Forcing the Main Unit to establish a connection to the Internet

With the Main Unit turned on the Rocker Switch **[A]** can be flicked on and off to instigate an immediate connection attempt, a Force Connect, FC. This can be useful if new settings have been made on the Web Portal. While connected the Main Unit will immediately receive the new settings without the delay of waiting for the next scheduled connection time according to set Connection Rate, CR.

3.7.2.2 Buzzer sound signals

Aside from the on and off signals explained in chapter 3.7.2.1 the buzzer can give information on other ongoing activity.

3.7.2.2.1 Data received

The buzzer sounds a two-note signal to indicate that a data package has been successfully received. This sound is typically repeated multiple times as Nodes send their data. During normal operation this series of signals are typically heard as the Nodes reach their scheduled upload interval time.



NOTICE This sound can be turned off using the advanced settings in the Web Portal.

3.7.2.2.2 Unpaired node in the vicinity

If a node not currently paired with the System seeks to initiate communication the buzzer plays a series of notes to indicate that the node is available for pairing. This signal is sounded with even intervals until the actual Node is either paired or reaches its time out for the establishment of a connection, typically ten minutes. If multiple nodes are trying to connect this signal will sound for an extended amount of time.



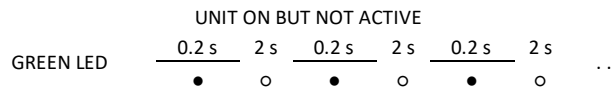
NOTICE The System is normally shipped with all included nodes already paired with the Main Unit. Pairing of Nodes to a Main Unit is not covered in this Instructions for Installation and Use. Contact your sales representative for help adding more Nodes to the System.

3.7.2.3 LED lamp indications

The status and current activity of Main Unit are indicated by the LED lamp indicators **[B]** flashing green or red in different patterns.

3.7.2.3.1 Unit on but not active

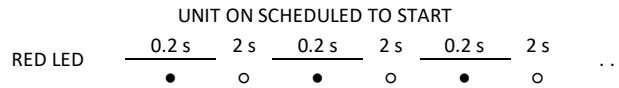
When the Main Unit is switched ON and no measurement session is in progress nor scheduled to start, the green LED indicator lamp blinks on and off in a slow pace. This indicates the Main Unit is waiting for a new measurement session to be initialized using the Web Portal.



NOTICE In this state no measured data is stored. Make sure a measurement session is active in order to collect and store data.

3.7.2.3.2 Unit on, scheduled to start

When the Main Unit has a measurement, session scheduled to start in the future but has not started yet the red LED lamp indicator flashes for 0.2 seconds every 2 seconds.

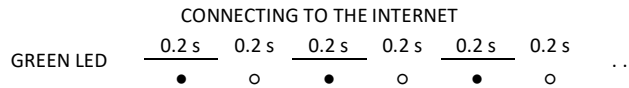


NOTICE No measurement data is stored or transferred when the Main Unit is in the modes described in sections 3.7.2.3.1 and 3.7.2.3.2. Make sure a measurement session is active in order to collect and store data.

3.7.2.3.3 Connecting to the Internet

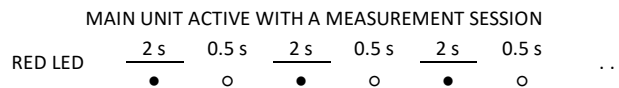
When the Main Unit attempts to establish a connection to the internet, the green LED lamp indicator flashes at a rapid rate. Connections are established during the following circumstances:

- Scheduled connections according to the settings made on the Web Portal, (the Connection Rate, CR), normally every five minutes.
- When the unit has just been turned on or off in order to convey this information to the Web Portal.
- If a user performs a Force Connect, FC, on a paired Node within the radio range of the Main Unit or if a Force Connect, FC, is performed on the Main Unit according to the procedure described in section 3.7.2.1.3.

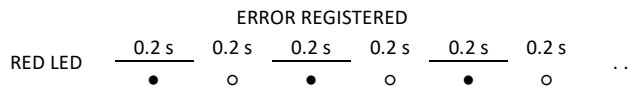


NOTICE A connection to the Internet can be instigated either by performing a Force Connect, FC, on a Node within the radio range of the Main Unit or by performing a Force Connect, FC, on the Main Unit by flicking the Rocker Switch between on and off once.

When the Main Unit is active with a measurement session, the red LED flashes with 2s long pulse and flashes OFF with 0.5s. This indicates that data is being collected and stored. This is the normal state during operation.



If there is an error code registered in the System, the red LED flashes with a stream of pulses of 0.2 seconds. This means that the unit cannot be used and possibly should be sent for repairs to an authorized service workshop.



4 Installation of the System on a Worksite

4.1 Setup overview

The first part of the installation process is to install the Technical Cabinet. This involves connecting the two antennas to the Technical Cabinet and to a mains outlet, turning the Main Unit on. It is then recommended to start a measurement session on the Web Portal in order to transmit the desired settings to the Main Unit and any Nodes later turned on.

The steps that needs to be taken when deploying the System on a new construction site can be summarized into these points:

1. Install the Technical Cabinet and turn the Main Unit on. See section 4.1.1.
2. Start a measurement session to be active for the whole duration of the project. See section 4.3.
3. Establish a connection with one or more nodes and install them at their respective measurement locations. See section 4.1.2 and 4.1.2.3 respectively.

NOTICE

A measurement session can be created even if the Main Unit is turned off. It will receive the new settings as soon as it is turned on again. Make sure to stop any ongoing measurement session as soon as the project is finished.

Once a Technical Cabinet has been installed it can be left turned on for the duration of the project. Nodes are then turned on and installed as they are needed. It is a good idea to store and charge the Nodes in the Technical Cabinet when they are not in use.

The steps that needs to be taken when taking Nodes into use on a site where a Technical Cabinet is already deployed can be summarized into these points:

1. Prepare thermocouples in advance and install them as necessary. See section 4.1.2.3.
2. Create control points on the Web Portal in advance. In order for the Node to be visible and available for a control point at least one of its data packages must have been transferred to the Web Portal. It must also be released from any already existing control point that it is already connected to. This is done by stopping the actual control point.
3. Select a Node to be used, turn it on and install it. See section 4.1.2 and 4.1.2.3 respectively.
4. After the measurement is finished the Nodes shall be collected and turned off before placed in the Technical Cabinet for charging again. See section 3.7.1.2.2.

NOTICE

Always turn off Nodes that are not in use. They will continue collecting data as long as they are on even if no thermocouple is connected. This creates massive amounts of useless data that will congest the uplink and further propagate through a chain of computer systems to no avail.

4.1.1 Installing the Technical Cabinet and turning the Main Unit on

1. Find an even surface preferably elevated at least 1 m from ground and in the close vicinity of a mains outlet (one phase, 100V- 240 V / 45Hz - 65Hz with protective earth).
2. With the Technical Cabinet flat down resting on its four plastic stands, open it and take out the antennas from the accessories bag.
3. Unscrew the protective blue caps on the antenna mounts by turning them counterclockwise and install the antennas by screwing them into place by turning the plastic lock nut clockwise **[A]**.
4. Connect the mains cable socket plug **[B]** to the mains power socket.
5. Check so that mains indicator light **[C]** is lit.
6. Turn on the Main Unit by pressing the rocker switch **[D]** to the “1” position. The Main Unit now starts up. This normally takes around 20 seconds but can take up to several minutes depending on the mobile phone network availability in the area. The blinking green indicator LED lamp **[E]** indicates that a connection is being established.
7. Detach a Node that later will be installed by slightly twisting it in the direction of the Main Unit and then gently pulling it outwards. When the node is detached from the charging bay the USB charging cable can be removed. See Illustrations page 1 for a more detailed description on node charging. Turn on the node and check so that it connects to the Main Unit.
8. Close and lock the Technical Cabinet. Never leave it open during normal operation. Place it in its upright position with the antennas pointing towards the sky to ensure optimal radio range.

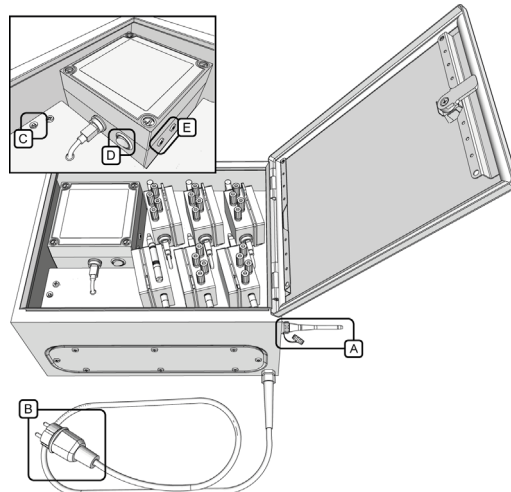


Figure 4 - The Technical Cabinet temporarily opened to access the Charging Bay and the Main Unit

⚠ WARNING

Read and follow the safety instructions concerning the placement of the Technical Cabinet and the particularly the mains cable found in chapter 2, Safety Instructions.

NOTICE

Do not touch exposed signal connectors directly as it can damage them due to electrostatic discharge (ESD) from the human body.

Do not use excessive force when installing the antennas or detaching the nodes or USB charging cable.

4.1.2 Installation of Nodes type N-TRF and N-TE

4.1.2.1 General preparation

4.1.2.1.1 Selecting suitable installation positions

It is recommended to define and document suitable installation positions in advance. The Nodes should be positioned close to the points of measurement and within the radio range of the Main Unit. If possible, the Nodes should be protected from unnecessary exposure of wind, rain and sun. A plastic bag over the Node after it has been installed will not affect the radio range but will prolong the overall lifetime of the Node. Excessive sun and rapid temperature changes can affect the accuracy of the measurement.

4.1.2.1.2 Select a node and carry it to the location

Detach the Node from the charging bay and visually inspect it looking for any damages to the antenna, connectors or keyboard. Turn the Node on and make sure it establishes a connection with the Main Unit. Also make sure that the node has enough battery to last for the duration of the foreseeable measurement period. While a node can run for quite a few days with a **BATTERY STATUS** indicating **WEAK** it is recommended to have at least half the battery capacity left indicated by at least two lit LED indicator lamps when the **BATTERY STATUS** is pushed. See chapter 3.7.1 for a more detailed description on how the Node user interface works.

NOTICE

If the Node battery is too weak, select another node from the charging bay and make sure that it is connected to the Technical Cabinet.

Carry the Node to the location where it should be installed. Push the **SIGNAL QUALITY** button and ensure the signal quality is at least **WEAK** as indicated by the lit LED indicator lamps. A flashing LED lamp under the **WEAK** headline means that the Node is too far away from the Main Unit - reconsider the installation location or move the Main Unit closer. Alternatively place a repeater node between the Node with the weak signal and the Main Unit.

NOTICE

Make careful notes of exactly where the Node was placed. Finding a Node on an ever-changing construction site can be very difficult without proper documentation.

4.1.2.2 Installation of Node type N-TRF

4.1.2.2.1 Ambient climate - Selecting suitable installation positions

The N-TRF Node measures the temperature and humidity in the air surrounding its sensor probe. It is recommended to place it shielded from rain. Extremely wet conditions will moisten up the sensor probe and possibly damage it.

Good locations outdoors are under a roof or other horizontal surface that shields the Node from wind, rain and direct sunshine. Indoors the Node should be placed around one meter above the floor. Placing the Node directly on a newly cast concrete slab will measure the humid climate directly above the surface which could lead to an over estimation of the air humidity in the room.

4.1.2.2.2 Ambient climate - Select a node and carry it to the location

The initial installation procedure is identical with the procedure described in section 4.1.2.2.2 for the Node type N-TE. Follow the instructions in the aforementioned section to finish the installation.

4.1.2.2.3 Pressure Sensor – Preparation and connection

Before starting installation, check sensors, housing and the membrane for damage and bubble-free filling to transfer the pressure from the membrane to the sensor. After ensuring that the Node has sufficient battery status and signal quality the pressure sensors can be installed.

When decided where to place the sensors, make sure that you place the sensors in correct order from the bottom e.g. position T1 followed by pos. T2, T3, T4. See figure 5.

Before drilling the holes for the sensors, check again that there is enough space for the sensor housings.

Mark the center of the hole with the template and pre-drill with a 3 mm. Then drill an opening in the formwork skin with a 50 mm hole saw.

Before inserting the sensor with housing into the opening, both must be greased. For this purpose, we recommend commercially available Vaseline.

Check that the sensor and housing are seated correctly and fix it with three screw to the formlining. Proceed in the same way when mounting the other sensors. When all the sensors necessary for the measurement are installed, connect the sensors to the Node using the bus connection cables as shown in the figure.

Concrete Pressure Monitoring Kit – Bus Connection Cables

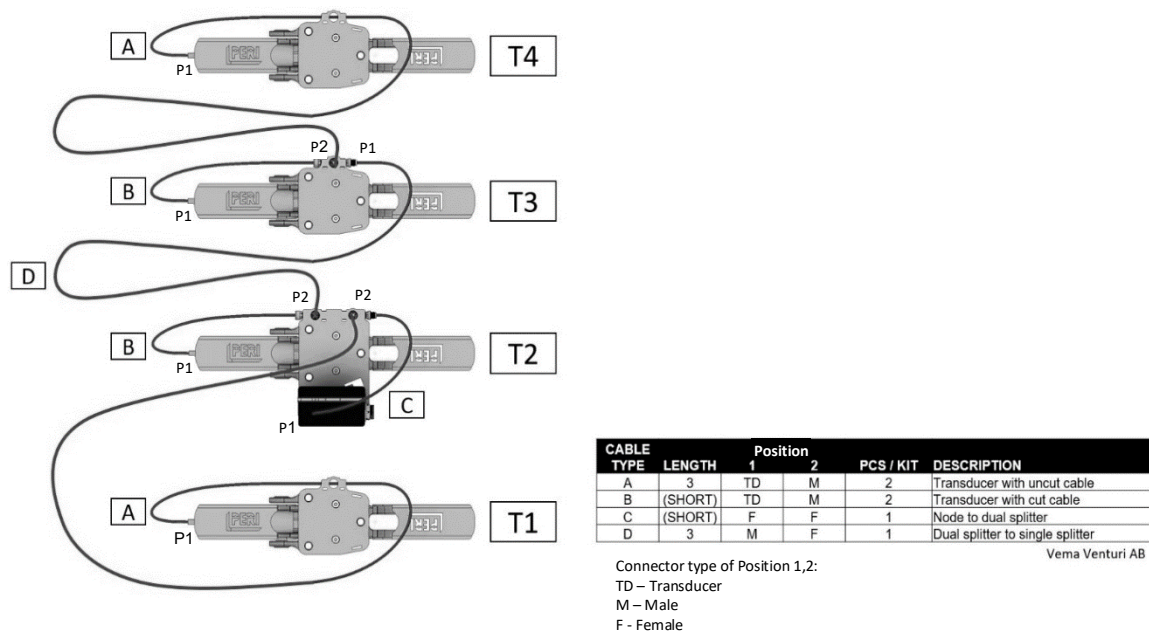


Figure 5: Connection and position of concrete pressure sensors

Starting the measurement

Make sure that the Main Unit is turned on and connected to the mobile network.

Select a project and a dashboard in the Insite web application and create a widget for the corresponding node.

We recommend replacing the names of the sensors in the widget with the installation height to make the display clearer.

Change the log and connection rate if necessary. The recommended log and connection rate for a fast pour are 20 seconds and 1 minute; for a normal pour 5 minutes each.

Set the start time of the measurement in the widget of the web application. Check again if the node is switched on and connected to the main unit. Make sure that the Node is sending data and that it is displayed in the web application.

Check if the display in the widget shows an offset without applying pressure. If so, choose a starting date and time before the pour, where concrete pressure is not applied on the sensor.

Removing the sensors after concreting

Make sure the concrete is strong enough before removing the sensors and housing.

First switch off the node and remove it. Then remove the bus connection cables between the housings and the Node.

Loosen and remove the fastening screws that secure the housings to the formwork skin. Lifting the metal brackets at the same time will release the sensor housing. Be careful not to damage the housing, the sensor and the membrane.

After removing the sensor and housing, remove concrete residues and dirt from the housing, sensor and membrane and check the parts for damage.

If necessary, close the openings in the formwork skin.

Stop the measurement manually in the widget of the web application if you have not set a stop time.

4.1.2.3 Installation of Node type N-TE – preparation and connection of thermocouples

Ensuring that the Node has sufficient battery status and signal quality the thermocouples can be installed to one or both input channels. Prepare the thermocouples according to the illustrations in Figure 5 where **[A]** is the end placed at the point of measurement and **[B]** is the end connected to the Node **[C]**.

Preparing the part for measuring **[A]** the leads in the measurement end should be stripped and twinned together. The length of the twinned pair should not be less than 15 mm. It is always easier to strip away a little bit extra of the insulation and then cut the leads to the right length after twinning them.

Protect the short-circuited measurement end with heat shrink or electrical tape.

Preparing the part to connect to a Node **[B]** and **[C]** it is recommended to strip the leads from the outer insulation at least 60 mm so that less bending forces are transferred to the inner leads when the cable is bent. The inner leads should be stripped long enough to ensure a good electric connection to the binding post connector on the node while at the same time not too long so that the leads risk short circuiting each other. Approximately 12 mm is sufficient.

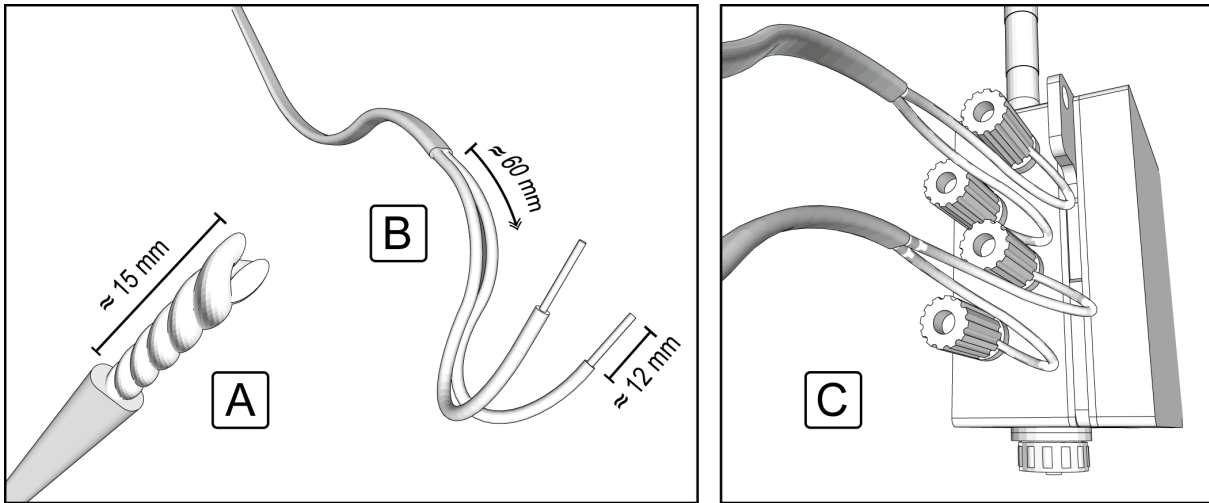


Figure 5 - The preparation and connection of thermocouples

NOTICE

Thermocouples should ideally be prepared and installed in good time before the pour while the rebar is still accessible and before the shuttering of forms.

Each channel has two gold plated turret type binding post connector.

Connect the brown lead to the brown connector and the white lead to the white connector.

NOTICE

Make sure there is no short circuit between the leads next to the binding post connector. Such a short circuit will cause the temperature at the short circuit to be measured instead of in the measurement point.

The channels are defined from their respective connector's position on the Node enclosure. Holding the Node with the antenna towards the sky the channel TOP is the uppermost input and the channel BOTTOM is the lowermost channel. When data is presented on the Web Portal these definitions are important to remember in order to evaluate the measured data.

Often it is of interest to monitor both the core temperature and the temperature close to the surface in a concrete structure. A wise regime to adopt is to use the TOP channel for the thermocouple placed near the surface and the BOTTOM channel for the thermocouple placed in the core.

When monitoring cooling pipes, the TOP channel can be used for the inlet while the BOTTOM for the outlet. Which channels are used where is of course completely up to the user's preferences but it is recommended to adopt a standard regime used throughout the project.

NOTICE

Make sure to document the Node number and channel used for each thermocouple. The thermocouples are normally not accessible after the pour.

4.2 Accessing the Web Application

Login to www.peri.instate.app using your credentials, if you already have a user account otherwise create a new one and follow the instructions.

4.3 Creating a project and starting a measurement session

To create projects and start measurement sessions you need to have the proper administrative rights. Contact your sales representative if you are unable to manage your Projects and Hardware using the Web Application.

4.3.1 Projects

Projects can be viewed on the starting page of the web application. Create a new project by clicking on "Create a new project" and enter the details like name and location of the project in the info box. Save the settings. You can change the settings by clicking on the cogwheel next to the project.

A project typically bears the name of the construction site and its Geographical location. Alternative names are possible.

Example: High rise towers – London

Each project can contain multiple dashboards with different measurements created from more than one System. Select the Main Unit to use from the list of available Main Units. The number of units visible in the list depends on how many units that are assigned to you. If no unit is visible – contact your sales representative.

NOTICE

A Main Unit can only be assigned to one project at a time. To release a Main Unit and make it available for another project click on the "finish project" button in the project settings. Already stored data and existing measurement sessions in the project disconnected from the Main Unit will not be affected.

When done click **Save**.

NOTICE

It is recommended to attain proper training before managing measurement projects. Contact your sales representative to learn more.

4.3.2 Dashboards and Measurement sessions

A new dashboard for a project is created by entering the name in the "Create New Dashboard" tile and confirming it by clicking "+".

In the dashboard, the hardware systems assigned to the project are displayed as widgets in the menu bar. In addition to the hardware widgets, there are also tool widgets.

First drag the widgets used for the measurement into the dashboard (see Figure 7).

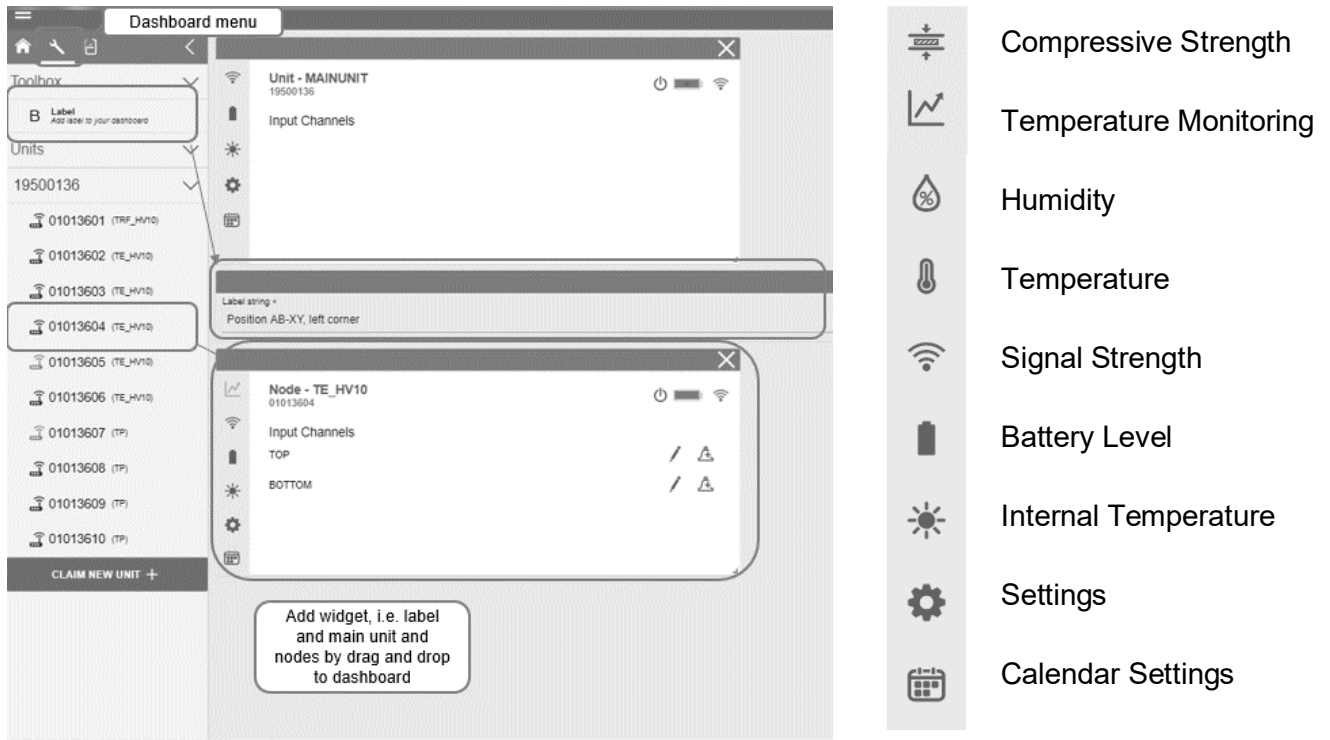


Figure 7: Web Application Dashboard with different widgets

A measurement session can be started by scheduling start and stop time in the calendar settings.

NOTICE With an increased number of managed projects and Main Units the difficulty level increases as well as the risk of making an error. Make sure you are working with the correct Main Unit and project when making changes.

Set the desired **Node Upload Rate (Connection Interval)**. This is the rate at which the nodes connect and upload data to the Main Unit in the “Settings” of the node widget. Normally three hours is sufficient but for users that want to see data more instantly for example 15 minutes is recommended.

Set the desired **Main Unit Connection Rate (Connection Interval) in the main unit widget**. This is the rate at which the Main Unit will connect to the Web Portal and upload data as well as fetch new settings. When the Main Unit is connected through the Technical Cabinet to the mains supply five minutes is recommended. For Main Units with battery only supply three hours is recommended.

Click **Save and send to the unit** to make the new settings available to the Main Unit on its next connection.

In the **different windows of the widget** the collected data can be viewed and analyzed using several web services.

The most common one is **Compressive strength calculation** where (provided the concrete's temperature sensitivity is known) the compressive strength can be calculated from the temperature measured by the Node connected to thermocouple placed in the concrete.

⚠ WARNING

The compressive strength can only be prognosticated if the concrete properties are perfectly well known. Using the wrong concrete data will lead to false predictions and possibly decisions being taken on the construction site based on wrong information. This could lead to serious risks!

To set up pressure monitoring in the web application proceed analogously.

5 Shut down, transportation and storage

5.1 Shutting down and finishing up

5.1.1 Ending the measurement session

Log in to www.peri.insite.app and click the red stop button on the actual measurement session. This will release the Main Unit and make it available for new projects.

5.1.2 Collecting the nodes

Collect all Nodes from their respective locations. If many Nodes are to be collected a suitable container such as a cardboard or plastic box is recommended. Do not use a bag or pouch since the Nodes will then likely rub against each other possibly activating the buttons or damaging the antennas.

NOTICE

Having documentation of exactly where the Nodes were placed is essential to recovering the equipment in an effective way. Finding a Node on an ever changing construction site can be very difficult without proper documentation.

Thermocouple cable can be reused multiple times, therefore make sure to cut the cable with pliers or a knife. Do not rip off the wire since this could damage the inner leads without any visible sign of failure on the outside. Such a damage could lead to measurement failure in a future project if the thermocouple wire is reused.

NOTICE

The Nodes and the Main Unit are electronics devices and as such they are more fragile than the Technical Cabinet. Therefore extra care must be taken while transporting the Nodes without the Technical Cabinet.

Inspect each Node for damages and clean them if necessary. Damaged Nodes should be taken out of use and be sent for repair. Turn off the nodes and return them to the Technical Cabinet where they are placed in the Charging Bay.

⚠ WARNING

Annex B describes the international transportation and packaging of products containing lithium metal and ion batteries according to UN38.3 and other regulations.

5.1.3 Shutting down the Technical Cabinet

Turn off the Main Unit and allow for at least a minute or two for the final connection with the Web Portal. Unplug the mains cable and wind it up. Carefully inspect the mains cable for damages. If the cable is damaged the System should immediately be sent to an authorized repair shop for maintenance. When the Main Unit has finished the connection to the Web Portal and no LED lamp indicators are flashing the antennas can be removed and placed in the Accessories Bag.

Place the accessories bag inside the Technical Cabinet. Make sure all nodes are turned off and then use the key to lock the door. Attach the key to the wound mains cable.

5.1.4 Transport and shipping

5.1.4.1 Transport

The Technical Cabinet can be carried by its carrying handle. Never transport the Technical Cabinet with the antennas mounted.

If the Technical Cabinet is transported by car, make sure it cannot enter the passenger compartment and injure the passengers in the case of an accident.

The Technical Cabinet is normally shipped from manufacturing in a high-quality double ply cardboard box. It is recommended that the same box is used for shipping. Figure 8 shows the Technical Cabinet placed in the cardboard box.

Maximum stacking height during transport in factory new cardboard boxes are four units on a pallet with sufficient securing.

Do not stack the equipment without proper packaging during transport.

Dimensions, L x W x H (cm):

Technical Cabinet	48 x 30 x 21
Cardboard box	50 x 50 x 28

Weight (kg):

Technical Cabinet	12
Incl. cardboard box and accessories	14

⚠ WARNING

Be careful when lifting and handling the equipment. Do not overstrain back muscles and watch your feet.



Figure 8 - Technical Cabinet

5.1.4.2 Batteries in the equipment

The System contains lithium ion batteries, and to transport the lithium ion batteries internationally it must comply with the following regulations:

1. Dangerous Goods Regulation (DGR) code International Air Transport Association
2. International Maritime Dangerous Goods (IMDG) code by International Maritime Organization
3. Technical Instruction Code for safe transportation of dangerous goods by air (TI), by International Civil Aviation Organization (ICAO)

Annex B details precautionary measures related to transport of lithium ion batteries and UN 38.3 by IATA in detail.

5.1.4.3 Storing the product

The Technical Cabinet is designed to withstand most weather conditions for a limited amount of time. Prolonged exposure to extreme conditions could however affect the lifetime of the equipment negatively. It is recommended that the System is stored protected from the extreme environmental conditions and be kept at nominal temperature ratings as described in 3.4.1.

To store the product safely:

1. Make sure the storing place is dry and the temperature and humidity is within the range as defined in product specification, section 3.4.1.
2. The Technical Cabinet is only to be used by skilled professionals; therefore it should not be kept within the reach of children.
3. Do not store near the source of heat and in high temperature environments.
4. Do not store the equipment exposed to rain, snow or in direct sunlight.
5. Do not stack other goods on top of the equipment.

Maximum stacking height during storage in factory new cardboard boxes are four units on a pallet with sufficient securing.

Maximum stacking height during storage of the Technical Cabinet without cardboard box is three units provided they are stored at floor level. Use protective sheets between the units to prevent scratching the paint on the door.

6 What to do in an Emergency

6.1 Fire or smoke

The Main Unit and the Nodes contain batteries of the type lithium ion. As such they contain substantial amount of energy and could pose a fire hazard if they are subjected to mechanical damage, over charging, short circuit or extreme temperatures.

In such an event the battery could undergo a rapid heating from the chemical reaction inside. Substantial amounts of white smoke could be generated, and the product could burst into flames.

⚠ WARNING The white smoke generated by burning lithium batteries is very toxic!

In case of fire, the cooling of the battery is of utmost importance. Use a fire extinguisher with carbon dioxide (CO₂), nitrogen gas, chemical powder, or foam to put out the fire. To avoid that the fire comes alive again after it has been put out it is recommended to empty all the content in the fire extinguisher even if flames are no longer visible.

In case of any contact with burning plastic or lithium ion batteries remove the contaminated clothes, gloves and shoes immediately wash the contact areas with plenty of water and soap, if appropriate measures are not taken it can lead to skin damages. Always seek medical assistance as soon as possible.

6.2 Electric shock (electrocution)

If the AC Mains cable to the Technical Cabinet is damaged or the Technical Cabinet is exposed to water in combination with a missing or faulty protective earth lead, it can cause an electrical shock.

⚠ WARNING Always take damaged equipment out of use! A damaged mains cable should be clearly marked as damaged or disposed of immediately.

An electrical shock can cause burns or leave no mark on the skin, either way electrical current passing through human body can cause internal damage, cardiac arrest or similar injuries.

Even a small amount of electrical current passing through human body can be very dangerous.

If an electric shock is suspected:

- a) Do not touch the injured person if still in contact with electrical current.
- b) Call the local emergency services e.g. 112 and do not get near the source of the current until the mains power cable is disconnected.
- c) Do not move the injured person unless the person is in immediate danger.
- d) Warn others of the possible electrical danger.

6.3 Concrete spilling to eyes and skin

When using the System near fresh concrete there is always a risk of getting concrete spilling on the skin or in the eyes. Concrete is alkaline and with a pH level of 13 and can cause damage to the eyes and skin.

Remove your goggles / contact lenses safely. Flush water with eyes open for at least 15 minutes and do not rub your eyes. Seek medical assistance if needed.

6.4 Physical Injury

The Technical Cabinet weighs around 12 kg and can cause broken bones and head injuries if it falls down on a person. In case of a deep head wound stop any excessive bleeding and immediately seek medical assistance. Always seek medical assistance if concussion or bone fractures are suspected.

7 Maintenance, Inspection and Replacement of parts

7.1 Inspection schedule

The System is a well-engineered and safe product. To ensure its continuous safe operation during its full lifetime it is important to inspect it for damages or excessive wear. Always follow this inspection schedule when using the System. Doing so will ensure safe operation and reduction of risks.

⚠ DANGER Risk of electrocution if the mains supply, the socket plug or the interior of the Technical Cabinet has been exposed to excessive amounts of water. Do not touch the equipment until the electricity has been shut off!

Task	Action
INSPECT THE MAINS CABLE ASSEMBLY	<p>Before and after installation:</p> <p>With the cable unplugged: Inspect the insulation along the entire length of the cable. Look for damages.</p>
When	<p>Inspect the socket plug as well as the cable gland going into the Technical Cabinet. If not, damages found – restore the mains connection.</p>
BEFORE AND AFTER INSTALLATION	<p>NOTICE Unplugging the cable for a short time will not affect the ongoing measurement session or data coming in.</p> <p>During operation:</p> <p>Make sure the power cable is routed in a safe way and that the socket plug or socket is not exposed to water.</p> <p>Unplug the cable – then continue to inspect the insulation along the entire length of the cable. Look for damages.</p>
WEEKLY DURING OPERATION	<p>⚠ WARNING Unplug the cable before inspecting it!</p> <p>In case of damages the equipment should be taken out of operation, marked as faulty or dangerous and then shipped to an authorized maintenance workshop.</p> <p>The mains cable should only be replaced by an authorized maintenance workshop.</p>

Task	Action
INSPECT THE ELECTRIC DISTRIBUTION CENTRAL AND THE LOW VOLTAGE PARTS	<p>This inspection cannot be done during operation.</p> <hr/> <p>⚠ WARNING It is recommended that this inspection is carried out by an authorized maintenance workshop.</p> <hr/> <p>With the cable unplugged: Remove Main Unit and the protective plastic cover. Inspect AC/DC power supply for damages or loose parts.</p>
When	
AT FIRST SIGN OF MECHANICAL DAMAGE TO THE TECHNICAL CABINET	<p>Inspect cables and terminal blocks as well as fixed PE-terminal block.</p> <p>Inspect the socket plug as well as the cable gland going into the Technical Cabinet.</p> <p>Inspect 5 V net, USB-connectors, and antenna sockets.</p> <p>Check resistance between mains socket plug PE lead and door hinges. Should be near 0 Ω.</p> <p>Check output voltage from AC/DC supply. Should be 5.1 V. Adjust if necessary.</p>
EVERY FIVE YEARS	

Task	Action
INSPECT THE MECHANICAL PARTS	<p>This inspection cannot be done during operation.</p> <p>Look for dents, cracks and water intrusion.</p> <p>Inspect the carrying handle, screws, resting pads, antenna connectors, door hinges and the internal mechanical parts.</p>
When	
AT FIRST SIGN OF MECHANICAL DAMAGE TO THE TECHNICAL CABINET	<p>Make sure the protective caps have their rubber packing and that the antennas are not damaged in any way.</p> <p>Cleaning</p> <p>Remove any concrete spilling, snow and ice or other contamination from the equipment.</p>
BEFORE AND AFTER INSTALLATION	

Replacement of parts

The System should only be repaired by specially trained service engineers and at manufacturers recommend places.

7.2 Replacement of parts, repairs, consumables, and accessories

7.2.1 User replaceable parts

The System has no user serviceable parts inside, however the radio antenna on the Node and the Technical Cabinet can be replaced by the user provided the respective connector on the unit is not damaged. The ambient climate sensor probe on the Node type N-TRF can also be replaced by the user.

The main fuse inside the Technical Cabinet should only be replaced by trained service engineers, in an authorized maintenance workshop or by a certified electrician.

Task	Tools
Radio Antenna replacement	None
Ambient climate sensor	None

7.2.2 Repairs only allowed by trained service engineers

⚠ DANGER

Faulty or damaged equipment should be taken out of use and be repaired by an authorized SERVICE PERSON. There are no user serviceable parts inside the equipment and opening it may lead to a possible hazard:

Parts inside carry mains voltage and the mains fuse is connected via the reversible plug. The equipment should be disconnected from the mains supply before any maintenance or repair work ensues.

Parts of the equipment that remain energized after the disconnection might represent a hazard during servicing.

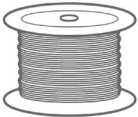
7.2.3 Replacement parts, consumables, and accessories

7.2.3.1 Replacement parts


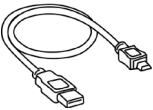
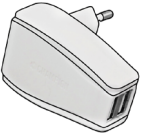
The parts listed below can be ordered and replaced by any skilled professional.

Image	Name	Article Number
	Ambient climate sensor probe	135884

7.2.3.2 Consumables

Image	Name	Article Number
	Thermocouple cable, type T, 150 meters	135882

7.2.3.3 Accessories

Image	Name	Article Number
	Pliers for preparation of thermocouple cable	135883
	USB charging cable for nodes	135879
	USB charger for nodes (EU)	135880

8 Troubleshooting

8.1 Errors, possible causes and solutions

Error	Cause	Solution
The Main Unit will not start up	Discharged battery	Make sure the Technical Cabinet is connected to the mains power and Mains Indicator Light on the Charging Bay lights up.
Discharged battery	No power from power supply	Check so that the USB-cable protruding from the charging bay is correctly inserted in the USB-connector of the Main Unit. If uncertain unplug it and plug it in again.
No charging	No power from power supply	Allow at least 20 minutes for the Main Unit to start up after it has been fully discharged. In order to protect the battery charging current is reduced during the initial charging phase ("trickle charge"). This is signaled by the red LED indicator lamp with a faint red glow.
The Mains Indicator Light on the Charging Bay is not lit even though the Technical Cabinet is connected to the mains supply	No power in the mains socket	Use another mains socket
	Technical Cabinet main fuse blown	Disconnect the Technical Cabinet from the mains power supply. Remove the Main Unit and change the fuse, 250V 1A. If needed use the spare fuse located on the Main Unit Mount Assembly behind the Main Unit.
Main Unit is on but absolutely no data is being uploaded	No measurement session active on the Web Portal	Inspect Web Portal settings and make sure the Main Unit is assigned to the correct project and measurement session.
	Broken antenna(s)	Inspect the antennas on the Technical Cabinet for damages and replace them as needed
Main Unit is on but data from one or more Node is not being uploaded	Broken antenna(s)	Inspect antennas on the affected Node for damages and replace them as needed Make sure they are sufficiently charged and within the radio range of the Technical Cabinet Check Node settings and try to do a Force Connect

8.2 Frequently Asked Questions

The most commonly asked questions by The System users are,

Q: Why doesn't the Main Indicator Light on the Charging Bay light up?

A: Make sure the power plug is connected to the mains and that the Mains Power Indicator LED is lit.

Q: Why is there no connection to the Web Portal?

A: Make sure the antennas of the Technical Cabinet are not damaged and are mounted correctly.

Q: Why is there no communication between the Node and the Main Unit?

A: Make sure antennas are properly installed on both the Node and the Main Unit. Make sure they are within radio range and not too close together (less than 1 m).

Q: Why does not the Node / Main Unit start even though they are charging?

A: Make sure the battery level of the Node and Main Unit are charged enough. A deeply discharged battery needs at least 20 minutes or up to an hour of reduced charging current (trickle charge) before it can start up. This is indicated by a faint red glow on the indicator LED lamps.

Q: Why doesn't the Node / Main Unit respond?

A: Make sure the battery is charged and that both are within the radio range.

Q: Why does the Node measure negative temperatures?

A: Make sure the thermocouple is installed with right polarity.

9 Disposal

The chapter covers the treatment procedures in accordance the EU directive on Waste Electrical and Electronics Equipment (WEEE). Generally, all metals (steel, copper) and its alloys, and precious metals can be recycled as material. Recycled parts such as rubber and plastic can be used in energy recovery.

Once the product has finished its life span it should be recycled according to the local regulatory. The System consists mainly of Plastic, metal, and electronics. Therefore, it is recommended to dispose The System and parts separately.

9.1 Disposal of electronic components

The symbol on the product, accessories or packaging indicates that device must not be treated as unsorted municipal waste but must be collected separately. Dispose of the device via a collection point for the recycling of waste electrical and electronic equipment (WEEE) within the EU and in other European countries that operate separate collection systems for waste electrical and electronic equipment. By disposing of the device in the proper manner, it helps to avoid possible hazards for the environment and public health that could otherwise cause by improper treatment of waste equipment. The recycling of materials contributes the conservation of natural resources. Therefore, it is recommended do not dispose electrical and electronic equipment with unsorted municipal waste.

9.2 Disposal of packaging waste

The packaging is made of environmentally friendly materials, which may be disposed through your local recycling facilities. By disposing of the packaging and packaging waste in the proper manner, it helps to avoid possible hazards for the environment and public health. The symbol on the packaging indicates that packaging is made of PAP.

To dispose of packaging the waste:

1. Sort paper and plastic packing materials separately
2. Plastic must not be recycled with paper packaging
3. Dispose the packaging waste at the local recycling sites.

9.3 Disposal of batteries

A crossed wheelie bin symbol is added on the compliance label of the product which indicates that the product must be recycled according to the EUs waste of electrical and electronic equipment (WEEE) directive (2012/19/EU). The batteries must not be disposed with the usual domestic waste. They may contain toxic heavy metals and are subject to hazard the waste regulations. It is recommended that the batteries and other electronic components on the devices must be recycled according to the local regulatory.



The horizontal bar underneath the crossed wheelie bin indicates that equipment was placed on the market after the directive came into existence in August of 2005.

9.4 Composition

The System is composed of four groups of materials:

Material	Weight
Plastic	≈220g
Metal (steel)	≈8.75 kg
Electronics and PCB	≈150g
Battery	≈50g

The exact weight of The System may vary due to the weight of electrical cables and accessories.

9.5 Disassembly of the System

After the System has passed its life span it must be recycled according to the local regulatory.

Most of the parts such as paper, metal (iron, aluminum) and plastic can be recycled at the local recycling stations according to the local regulatory, but the components containing possible hazardous substances such as lead (Pb) Mercury (Hg) and the Cadmium (Cd) must be recycled according to the EU legislation of RoHS as they can present hazards to the public health and environment. The components used in system are according to the RoHS directive (2011/65/EU). Parts such as batteries and electrolytic capacitors should be recycled separately according to the EU directive on RoHS (2011/65/EU). Extra precautions must be taken while disposing the batteries.

A complete list on Restriction of Hazardous Substances (RoHS) is attached in Annex A.

9.6 Recycling the Technical Cabinet

To disassemble the product following steps should be taken:

1. Pull the lock pins from both hinges to remove the door. Recycle as steel.
2. Remove the Main Unit, pry away the circuit board and recover the battery, recycle the rest as electronic waste. The lithium ion battery should be recycled separately according to the local regulatory requirements.
3. Remove the Charging Bay and cut loose all wires. Recycle the Charging Bay panel as aluminum and the cables as electronic waste.
4. Remove the Main Unit mount assembly and recycle as aluminum.
5. Remove the power distribution system as well as the antenna foot mount and recycle as electronic waste.
6. Remove the carrying handle and recycle as plastic.
7. The rest can be recycled as steel.

9.7 Recycling of the Nodes

To disassemble the Nodes the following steps should be taken

1. Open the enclosure.
2. Locate the lithium ion battery and recycle it separately according to the local regulatory requirements.
3. The PCB should be recycled as electronic waste, the rest as plastic.

10 Annexes - RoHS, li-ion battery transportation regulation

A

I. Annex II RoHS Directive.

Restricted substances referred to in Article 4(1) and maximum concentration values tolerated by weight in homogeneous materials

Lead (0,1 %)

Mercury (0,1 %)

Cadmium (0,01 %)

Hexavalent chromium (0,1 %)

Polybrominated biphenyls (PBB) (0,1 %)

Polybrominated diphenyl ethers (PBDE) (0,1 %)

Bis(2-ethylhexyl) phthalate (DEHP) (0,1 %)

Butyl benzyl phthalate (BBP) (0,1 %)

Dibutyl phthalate (DBP) (0,1 %)

Diisobutyl phthalate (DIBP) (0,1 %)

B

ANNEX B

Lithium metal and Ion battery transportation regulation according to UN38.3

Transport information.

The packages containing lithium ion batteries are classified as class9 (miscellaneous dangerous goods). For the international transportation of the lithium batteries they must comply with UN recommendations on the transport of dangerous goods. If lithium ion batteries comply with UN 38.3 (UN manual and test criteria, part III, subsection 38.3) they can be transported as ordinary goods and can be transported by means of Marine and Air transport. Otherwise they should be declared and transported as dangerous goods.

The dangerous goods should be packed according to class 9 (UN 3080, Lithium Ion Batteries, UN3090 Lithium Metal Batteries), packing group II hazardous goods.

If lithium batteries are used inside as part of the equipment (to power the equipment) or packed separately, they are classified as:

- UN3091 Lithium metal batteries contained in equipment or
- UN3091 Lithium metal batteries packed with equipment.
- UN3481 Lithium ion batteries contained in equipment, or
- UN3481 Lithium ion batteries contained with equipment.

If the quantity of lithium ion batteries are small as compared to packaging of the equipment, it may be exempted from most of the International Air Transport Association (IATA) and International Civil Aviation Organization (ICAO) requirements if they comply with the requirements in section II IATA packaging instructions (PI) 966 and 967 for lithium ion batteries and 969 and 970 for lithium metal batteries. [iata.org]

The lithium batteries should be packed according to section II of IATA packaging requirements during the shipment of the equipment that contains the lithium batteries inside or as part of the shipping equipment. The section II of IATA packaging requirements provides that the metal or any alloy cell content do not exceed than the 1g per cell and 2g as an aggregate per cell. [iata.org]

The state of charge (SoC) on lithium batteries for transportation should be maximum of 30% of the full charge.

Prohibitions

There are some extra considerations that must be made before the shipment of the lithium ion batteries according to the International Air Transportation Association (IATA). These includes and may not be restricted to,

Lithium Metal Batteries

The lithium metal cells and batteries shipped by themselves (UN3090) are forbidden for transport as cargo on passenger aircrafts. The packages must be prepared according to packaging instructions (PI) 968, section 1A, 1B and section II. The shipment must be marked "Cargo aircraft only" in addition to the other marks and labels.

Lithium Ion Batteries

The lithium ion cells and batteries shipped by themselves (UN3480) are forbidden for transport as cargo on passenger aircrafts. The packages must be prepared according to packaging instructions (PI) 965, section 1A, 1B and section II. The shipment must be marked "Cargo aircraft only" in addition to the other marks and labels.

Restrictions

The lithium ion cells and batteries (UN3480 only) during the shipment, must not be higher than 30% of its full charge capacity. The lithium cells/batteries at a state of charge (SoC) greater than 30% only be shipped with the approval of state of origin and the state of operator under the written conditions established by the authorities. Further details are described in A331 special provision.

Restrictions on packaging

Section II (PI 965 and PI 968)

According to the IATA the lithium cells and batteries must not be packed with other dangerous goods with same outer packaging. The packaging instruction (PI 965 and PI 968) of section II illustrate further information.

Section 1A, 1B (PI 965 and PI 968)

UN 3090, lithium metal batteries prepared according to section 1A and 1B of PI968 and UN3480, lithium ion batteries prepared according to section 1A or 1B of PI 965 must not be packed in the same outer packaging with other dangerous goods classified in class1 (explosive goods) other than division 1.4s, division 2.1(flammable gasses), class 3 (flammable liquids), division 4.1 (flammable solids) or division 5.1 (oxidizers).

The packages containing cells or batteries must not be placed in an over pack with packages containing dangerous goods classified in class 1 other than division 1.4S, division 2.1, class 3, division 4.1 or division 5.1.



Fig. IATA class 9 miscellaneous goods label

The shipment of lithium cell and lithium batteries must contain labeling information according to 60th edition of IATA Dangerous goods regulation 2019.

- All hazards and handling labels must conform in shape, format, symbol and text as shown in the regulations, all other are forbidden.
- The label must be affixed beside the name and address of the shipper or consignee on the package.
- The label of dangerous goods must be visible and should be placed on the top of the packaging and should not be covered by any other obstacle attached to the packaging.'
- Large packages should be labeled on the two opposite sides.
- The damaged or irrelevant labels already on the over pack should be removed.
- The hazard label must conform the regulations for the minimum dimensions and should be placed on goods in diamond shape (45°)

NOTICE	It is shipper's responsibility to apply label and make provisions.
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Related Regulations:

The following regulations should be considered and cited.

Air Transport	IATA (International Air Transport Association)/DGR (Dangerous Goods Regulation) ICAO (International Civil Aviation Organization) TI (Technical Instruction)
Maritime Transport	IMO (International Maritime Organization) / IMDG (International Maritime Dangerous Goods Code)
Land Transport	RID (International Carriage of Dangerous Goods by Rail) ADR (International Carriage of Dangerous Goods by Road)
USA / UN	USDOT - (United States Department of Transportation) / DOT 49 CFR 173.185b Code of Federal Regulations (Administrative Law) UN – Unites Nations recommendations on the transport of dangerous goods. Model regulations Volume I 20 th edition (ST/SG/AC 10/1/Rev.20) 2017. Part III, subsection 38.3

EUs directive 2013/56/EU must be considered for environment related laws of batteries.

Hardware Versions (HV)

Device	Year	Hardware	Description
Main Unit	2016	HV 03	Generation III mother board
	2019	HV 04	Generation IV mother board
Node	2016	HV 09	Generation IX node
	2019	HV 10	Generation X node

Document Revisions

Date	Version Number	Document Changes
2013-03-05	1.00	First version
2013-03-08	1.01	Minor revision
2014-08-07	1.02	Installation and FAQ chapters added
2014-08-30	1.03	Minor revision
2014-11-23	1.04	Minor revision
2015-04-07	1.05	Minor revision
2016-11-02	1.06	Functional flow chart for nodes added
2019-09-30	2.00	Revision to cover new functionality
2019-12-05	2.01	Illustrations and improved functional description
2019-12-19	2.02	Minor revision with additional features
2020-06-15	2.03	Minor revision
2021-03-24	2.04	Minor revision, Pressure sensors included, Web Application updated